

Web Unit Plan

Title: Go-Go Gadget

Description: Young inventors put their knowledge of simple machines to the test as they create new, labor-saving machines of their own!

At a Glance

Grade Level: 3–5

Subject sort: Science, Math

Subject(s): Physical Science, Math

Topics: Work, Force, Motion, Data Analysis

Higher-Order Thinking Skills: Creativity, Analysis, Data Analysis

Key Learnings: Simple Machines, Compound Machines, Mechanical Design

Time Needed: 4–5 weeks, 45-minute lessons, 3 times per week

Background: Texas, United States

Unit Summary

Students study the concepts of force, motion, and work as they analyze simple machines. They study the simple machines in complex machines, and track the transfer of force from input (effort) to output (work). Students collect, organize, represent, and analyze data from a human automation investigation using spreadsheet software. In a design challenge, students become inventors and identify work they want to perform, and then they invent labor-saving machines to do the jobs. The design steps of planning, drafting, construction, troubleshooting, and reliability testing are followed before students unveil their wonderful inventions to an awed crowd.

Curriculum-Framing Questions

- **Essential Question:**
How can we make life easier?
- **Unit Questions:**
How do I invent a machine to do my work?
What changes when human work is automated?
- **Content Questions:**
What are the definitions of force, motion, and work?
What are the six basic simple machines and their uses?
What is the difference between a simple and compound machine?
How can I collect, represent, and analyze data to help me understand?

Instructional Procedures

Preparing for the Unit

Read the [teacher background information](#) document to get a basic introduction to simple machines. Collect books on machines to have them available for student use.

Introducing Simple Machines

Pose the questions, *What are machines?* and *Do we need them in our everyday lives?* Have students brainstorm different types of machines, how the machines are used, and if they think the machines are needed in everyday life. Record student

responses on chart paper. Ask students to write their thoughts about machines in their science journals. Have students begin to think about the Content Question, *What are the definitions of force, motion, and work?*

Begin instruction with the definition of *work* and proceed to the use of machines as labor-saving devices. Introduce the six basic simple machines—the lever, pulley, and the inclined plane—and their modified cousins—the wedge, wheel and axle, and screw to answer the Content Question, *What are the six basic simple machines and their uses?* Show students a variety of simple machines (these can be collected readily or found in kits, such as the Great Explorations in Math and Science (GEMS) Simple Machines kit). Divide students into two groups, and have one group investigate the simple machines while the other studies the following simple machine Web sites: [Understanding Simple Machines](#)* and [Edheads](#)*. Encourage the hands-on group to experiment with the machines and show each other how force is applied to a machine to move a load over a distance (accomplishing work). Take anecdotal observational notes as students work to make sure students understand the difference between effort and work. After a specified time, have groups switch, so all students receive hands-on experimentation and investigation. Ask students to record their findings and what they have learned in a science journal, and then have students share what they have learned with the rest of the class. Write questions on the board for students to use as a guide while they are working.

Following the introduction of simple machines and how they function, challenge students to use digital cameras to take pictures of as many examples of simple machines as they can around the school. Have students use graphics software to label and explain their photos and use the labeled photos for a wall display. Ask students to investigate machines further by completing activities found at the following Web sites: [Work Is Simple with Simple Machines](#)* and [Marvelous Machines](#)*.

Conducting Independent Study on Composite Machines

Set students to work in pairs, studying from bookmarked Internet sites. Have them describe the six simple machines and give examples of each on a [research worksheet](#). Student-friendly sites, such as [Franklin Institute's Simple Machines](#)* and [Inventor's Toolbox](#)*, are good starting points.

Introduce students to the concept of composite, or compound, machines to answer the Content Question, *What is the difference between a simple and compound machine?* Choose an example compound machine (such as an old-fashioned egg beater) to show how simple machines are combined to create a more complicated machine. Show how the force is transferred from simple machine to simple machine within the compound machine. On a projected computer image, show students the [lawn mower site](#)* and analyze the machine to identify all the simple machines that work in concert to make a lawn mower mow. [Edheads](#)* could be explored again for more simple and compound machine review.

As a homework assignment, ask students to find fairly simple compound machines they can bring to school. When the class has a large assortment, rotate the machines through small groups, and challenge students to describe the simple machines in each. Take digital photos, import the photos into a drawing program, and then have students analyze the machines, label the component machines, and identify the mechanics through which force turns into work. At this point, have students begin to think about the Essential Question, *How can we make life easier?*

As students brainstorm, log their responses on chart paper. Students could record their own thoughts in a science journal.

Asking Thought-Provoking Questions

Post the Unit Question on the board, *What changes when human work is automated?* Organize students into small groups of three or four to discuss the question in a round-robin, allowing each student to give an answer. Take observational anecdotal notes to assess students' level of understanding and to help develop thought-provoking questions for a follow-up discussion. After students have had the opportunity to share their answers to the question, have individuals share with the whole group. Record students' thoughts on chart paper. Next, have students begin to think about machines that automate human work, including ATM machines, self-checkout stations at supermarkets, dishwashers, washing machines, and so forth. After students have had an opportunity to share their ideas, bring the discussion back to the whole group. Have students share their ideas and discuss the changes that have occurred when work is automated. To facilitate the discussion, ask the following questions:

- *How have machines changed the way people do work at home and at their jobs?*
- *How have machines affected the time and effort people spend doing different kinds of work? Are these changes positive or negative?*

After the discussion, ask students to record their responses in their science journals.

Conducting a Human Automation Investigation

For homework, ask students to choose a machine that they use at home and time how long it takes to complete a certain task. They then time themselves doing the same job to see how much more or less time it takes. For example, students could run the dishwasher, first counting the number of dishes, cups, and silverware. Then they could wash one of each and multiply or do repeated addition to figure out how long it would take them to do the entire load. Tell students to bring the information to class.

Creating a Spreadsheet

Using the students' homework assignment information, spreadsheet software, and a projector, show students how to create a spreadsheet from scratch to display and analyze the class data. Use the instructions for [creating a spreadsheet](#) and the sample [human automation data](#) spreadsheet to help guide the process.

Analyzing the Data

Distribute the class [human automation data](#) spreadsheet and ask students to compare the time it takes them to do the job on their own against how long it takes them to do the job with a machine. Have students analyze their findings and record their thoughts in their science journals.

Creating Inventions

Ask the Unit Question, *How do I invent a machine to do my work?* Have students begin to think about inventing a machine that could help them in their everyday lives. In this activity, have groups of three or four students take on the role of inventors and use their new expertise to invent novel uses for simple machines. During this process, encourage students to enhance their creativity by thinking of as

many ideas as they can before they decide on one to use in their project. First, ask students to begin by brainstorming tasks in their lives that might be done by machines. Then, ask students to experiment with making a variety of simple machines to perform tasks. Finally, have each group settle on one type of machine and one kind of work they want it to do.

Creating, Troubleshooting, and Testing Inventions

Set aside a period or more for groups to construct and troubleshoot their devices. Have the groups use spreadsheets to evaluate their machines and determine their laborsaving qualities in some quantifiable way. For example, students may want to record speed or load trial data, or set up machine-aided versus human-powered contests. Circulate among students as they work to conduct informal conferences to ascertain understanding of concepts and processes, and to provide guidance, if necessary, to correct misunderstandings.

Ask students to take photographs or video of the machines in action. (If photographs are imported into a drawing program, labels can be added showing how the work is accomplished.) Products and tests are saved and incorporated into a presentation.

When the projects are completed, ask students to self-assess their creativity during the process using the [creativity checklist](#).

Creating Student Multimedia Presentations

Show students how to create a slideshow presentation using the [presentation rubric](#) as a guide so students are aware of what quality work looks like. Have students use the [student checklist](#) to help guide them as they develop their presentations to ensure they have included all of the required components.

After students create their multimedia presentations, have them present their machines to the class and demonstrate how they perform work, supporting their talk with their [Gadget Slideshow](#).

Concluding Activities

Have students revisit the Essential Question, *How can we make life easier?* in small- and large-group discussions. Students can participate in a mock debate as they begin to discuss the pros and cons of using machines to make life easier using their inventions as evidence. Ask students to record their thoughts in their science journals as a final activity.

Prerequisite Skills

- Students may need mini-lessons on spreadsheet and multimedia use.
- Prior experience with word processing and file management is helpful.
- Previous cooperative learning and scientific method/process investigations would be beneficial.

Differentiated Instruction

Resource Student

- Make modifications as dictated in the student's Individual Education Plan (IEP)
- Use cooperative grouping
- Present instructions in a variety of ways
- Break down tasks into component parts

- Allow extra time for completing assignments
- Use assistance from a parent, volunteer, or teacher's aide
- Provide teacher-created templates and graphic organizers
- Provide positive reinforcement for each accomplished benchmark

Gifted Student

- Provide an individual research project
- Have the student plan and organize a simple machines display
- Provide extension activities, such as visiting [Leonardo's Mystery Machines](#)* where the student can observe a diagram of a machine and identify its purpose
- Have the student visit [Rube Goldberg's Gallery](#)* and describe the sequence of the diagram and then invent a Rube Goldberg machine
- Ask the student to identify the different machines that would help solve the dilemma in [Project Treehouse](#)*

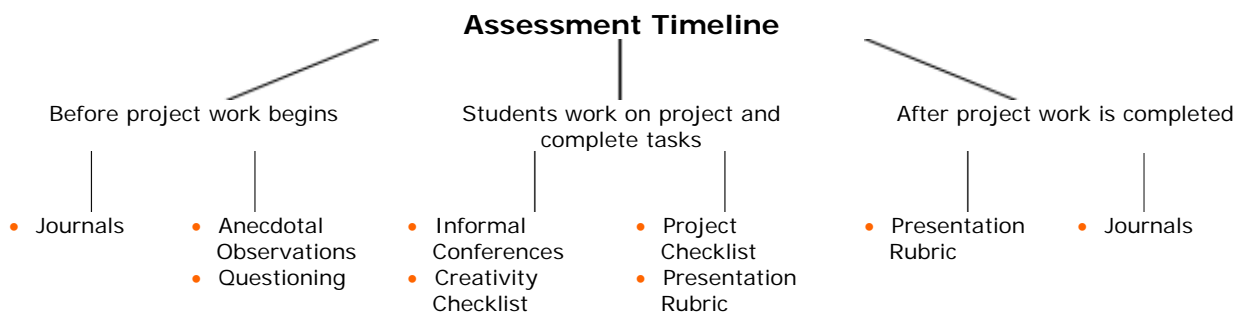
English Language Learner (ELL)

- Use cooperative grouping
- Encourage support from common language speakers who are more proficient in English
- Grant extra time for completing assignments
- Use assistance from a parent, volunteer, or teacher's aide
- Provide teacher-created templates and graphic organizers

Assessment

THINGS YOU NEED (highlight box)

Assessment Plan



Before beginning to study simple machines, use students' journal entries to determine prior understanding of the topic in order to plan instruction and address individual and group needs. As students manipulate various kinds of simple machines and explore relevant Web sites, take anecdotal notes to assess student understanding of the concepts of *force* and *work*.

While students discuss the effects of automation in small groups, take notes to help with the development of questions to deepen students' thinking. During the large-group discussion, ask probing questions to highlight areas of incomplete knowledge and misunderstanding of basic concepts.

As students work with a small group to create a new invention, conduct frequent, informal group and individual conferences to determine students' ability to apply

their learning about simple machines. After students have created their machines, ask them to self-assess their creativity with the [creativity checklist](#).

As students create multimedia presentations to share their projects, students use the [project checklist](#) and the [presentation rubric](#) to help them manage their time and to make sure that their presentation meets the expectations for quality. The completed presentation is assessed with the presentation rubric. Finally, journal entries describing what students have learned can help dictate what topics need to be readdressed in later units.

Credits

Two teachers who participated in the Intel® Teach Program contributed this idea for a classroom project. A team of teachers expanded the plan into the example you see here.

Targeted Content Standards and Benchmarks

Targeted Texas Content Standards and Benchmarks Science Texas Essential Knowledge and Skills (TEKS)

- Demonstrate safe lab practices
- Plan and implement investigations
- Collect information by observing and measuring
- Construct explanations
- Construct graphs, tables, maps, and charts
- Collect and analyze information using tools
- Demonstrate that repeated investigations may increase reliability
- Connect concepts with the history of science and contributions of scientists
- Use models and identify limitations

National Educational Technology Standards (NETS)

- Use technology tools to enhance learning, increase productivity, and promote creativity
- Use productivity tools to collaborate in constructing technology-enhanced models, prepare publications, and produce other creative works
- Use technology to locate, evaluate, and collect information from a variety of sources
- Use technology tools to process data and report results

Student Objectives

Students will be able to:

- Understand the difference between effort and work
- Describe simple machines and tell how they accomplish work
- Identify how simple machines are used in daily life
- Identify simple machines that work together as components of more complex machines
- Measure and record changes in the position and direction of the motion of an object to which a force such as a push or pull has been applied
- Use a spreadsheet to collect, sort, and display data
- Use scientific processes to create a new simple machine
- Evaluate mechanisms of newly designed simple machines
- Create a multimedia presentation to synthesize learning

Materials and Resources

Printed Materials

- Hewitt, S. (1998). *Machines we use*. New York: Children's Press.
- Hodge, D. (1998). *Simple machines starting with science*. Buffalo, NY: Kids Can Press.
- Jones, C. (1991). *Mistakes that worked*. New York: Doubleday Dell Publishing Group, Inc.
- Nankivell-Aston, S. (2000). *Science experiments with simple machines*. New York: Franklin Watts.
- Richard, J. (2000). *Work and simple machines*. Brookfield, CT: Copper Beech Books.
- Wells, R. (1996). *How do you lift a lion?* Morton Grove, IL: Whitman Publishing.

Supplies

- Science journals
- Data collection and measurement tools, such as stopwatches, balance scales, and measuring tapes

Internet Resources

- Boston Museum of Science
www.mos.org/sln/Leonardo/InventorsToolbox.html*
Inventor's Toolbox on this site provides information on simple machines
- COSI Science Center, Columbus and Toledo, Ohio
www.cosi.org/files/Flash/simpMach/sm2.html* (Macromedia Flash Player* is required.)
Best used as a guided demonstration
- Hands-On Technology, Marvelous Machines
www.galaxy.net/~k12/machines*
Series of experiments involving simple machines
- The Franklin Institute
<http://sln.fi.edu/qa97/spotlight3/spotlight3.html>*
Simple Machines section shows six simple machines in action
- Rube Goldberg Gallery
www.rube-goldberg.com*
A collection of Rube Goldberg inventions
- Project SMART96
www.ed.uri.edu/SMART96/ELEMSC/SMARTmachines/machine.html*
A collection of classroom activities
- *Design and Discovery* Key Concepts
www97.intel.com/DISCOVER/DesignDiscovery/DD_Session5/default.aspx
Background information on simple and compound machines

Other Resources

- Simple machines lab kit (GEMS from the Lawrence Hall of Science offers one, as well as a separate levers and pulleys kit) or other materials for creating a simple machines

Technology—Hardware

- Digital camera to take pictures of simple machines for wall display
- Internet connection for online lessons and Web site exploration and research
- Projection system to project lawn mower site for all students to participate together
- Scanner to scan pictures of simple machines that can be printed and labeled
- Video camera to take video of student machines in action

Technology—Software

- Database or spreadsheet for graphing activities
- Desktop publishing software to publish multimedia presentation
- Encyclopedia on CD-ROM for simple machine research
- Image processing software for labeling simple machines